NASA TECH BRIEF

Lewis Research Center

High-Temperature Strength of Prealloyed-Powder Products Increased by Heat/Pressure Treatment

The high-temperature strength of products formed from prealloyed powders can be increased by a new process involving heat treatment above the solidus temperature (that temperature at which the material first begins to melt) followed by the application of pressure at a temperature below the solidus point.

Presently, prealloyed-powder techniques are used to increase the strength of superalloys at temperatures up to 1500° F. At higher temperatures, however, the strength of prealloyed-powder products decreases markedly compared to that of cast-alloy products. Prealloyed-powder techniques yield products with a very fine grain size, and grain growth is required for increased high-temperature strength. Due to the complex nature of many superalloys, very high heat-treatment temperatures are needed to achieve grain growth. In many cases, adequate grain size cannot be achieved by conventional heat-treatments below the solidus temperature.

A novel, two-step heat treatment, used on products formed from HS-31 prealloyed powder, overcomes this difficulty. The treatment involves heating the products to a temperature above the solidus (above about 2340° F, in the case of HS-31), and subsequently applying pressure at a temperature below the solidus. Significant grain growth is achieved during the initial step of heat treatment at 2450° F, but structural integrity is lost because of minor phase melting and void formation. The voids are closed and structural integrity is restored by secondary treatment in an autoclave, at 30 ksi and 2200° F. Life-to-rupture at 1800° F and 13 ksi is increased to 20 hours by the heat/pressure treatment, as compared to less than one hour for the as-extruded powder product and approximately ten hours for castalloy product.

This result suggests that the high-temperature properties of other prealloyed-powder products could be improved by heat-treatment above the solidus temperature, followed by the application of pressure below the solidus temperature. The technique can be modified to a one-step process involving the simultaneous application of both high pressure and heat. Also, the technique is not limited to cobalt-base alloys.

Notes:

1. Related information is contained in NASA Tech Brief 69-10293.
2. The following documentation may be obtained from:

   National Technical Information Service
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.95)

   Reference:
   NASA TN-D-6072 (N71-10326), Evaluation of a Cobalt-Base Alloy, HS-31, Made by Extrusion of Prealloyed Powders
3. Technical questions may be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B71-10489

Patent status:

This invention is owned by NASA, and a patent application has been filed. Royalty-free nonexclusive licenses for its commercial use will be granted by

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NASA. Inquiries concerning license rights should be made to:

Patent Counsel
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